

## Literature Review

This project requires a good understanding of neural networks and how they can and have been used to create models that extract data from images and to classify them based on that. Furthermore, research is needed for every new model to best visualize the results, maximize the accuracy and explain possible reasons why a model might not perform at a reasonable capacity.

For this reason, this section will highlight sources that explain or show how such a model can be built and optimized, data and results are being visualized, concepts about neural networks and machine learning, and models which were made to address a similar problem as to the one I am trying to solve.

## Machine Learning

Machine learning belongs to the science of Artificial Intelligence, it is the concept of a system that can learn and improve itself without the help of someone else to program those improvements into it and allows a stage of improvement without being initially programmed at that stage. (Byju's Gate, 2022) They become more accurate the more data they acquire e.g. a music recommendation algorithm that becomes better the more users with similar music taste/history are in the system.

## Deep Learning

Deep learning exists as a subset of machine learning, the difference with deep learning is, that it uses multiple processing layers to learn how the representations of data in multiple levels of abstraction, this distinction has allowed it to drastically improve the capabilities of AI in problem domains such as image and voice recognition, object detection and many more.

It does so by creating a neural network and readjusting the internal parameters called the weights, which exist for each connection between nodes across layers, each weight determines the output value of a node up to the output node.

This process of readjusting the weights is called backpropagation. (Lecun Y. et al, 2015).

## Convolutional neural networks

A neural network is a network of nodes similar to neurons in our brain, each node can send a signal to another node it is connected to with a certain strength which for machine learning is called the weight, the weight is a real number usually between 1 and -1, as nodes are grouped in layers when a node receives the input from all its connected nodes from the previous layer or the raw input if it is at the first layer it will take all these values and decide which node to signal next, which signal is sent depends on the outcome of the activation function for that node, which then gets multiplied by the weight of that connection, this process continues until a node in the output layer is reached and the output of that node in that layer is produced, after which it will readjust the weights to maximize the accuracy of the final output (Code Bullet, 2018).

There are however different ways in which such neural networks are composed one such method are Convolutional neural networks which are designed to process data that comes in the form of multiple arrays, such as images which can be processed as 2D arrays where each

array element represents the RGB (red, green and blue) value for a given pixel present in an image. It is designed to make use of key concepts which are local connections, shared weights, and pooling, as pixels in certain colours often appear in groups and are related to each other, such as a red pixel from a red balloon logically accompanied by other similarly red pixels from which we can deduce that the red pixels in that area are semantically the same, and finally the use of many layers. (Lecun Y. et al, 2015).

### Similar Work

There exists an incredible amount of research in the field of machine learning and neural networks for the purpose of image classification, there exists a multitude of models which address all kinds of problems.

Among those, there are some models that addressed the same or a very similar problem domain as mine, such as an image classification model that aims to classify the structure of a fabric based on an image by Yasith Sanura Perara (2020).

That model happens to have used the same dataset that I am going to use to train the model, so it is a very good report that addresses issues that I may come across myself, and the paper for which the dataset was made by C. Kampouri et al. (2016) will serve as a source for other techniques that I could apply.

### Data expansion through augmentation and Fabric identification

Convolutional neural networks or any machine learning model works better the more data is available to it, other models usually receive thousands of images or even to a million depending on the range of objects they have to classify and how subtle the differences among them maybe, as the more data the model receives the better it can understand the important features for each type of object.

As in my case, I have the problem of having a limited set of unevenly spread data where some fabric types are better represented than others, I have identified that I may need to artificially create more data through augmentation on my available data. For this purpose I have been reading through the article by Arun G. (2021) about data augmentation, its effects on data, the identification of proper augmentation options, and the limitations and problems that may arise with certain augmentation techniques, through this article, I have identified that flipping the images vertically and horizontally is a safe form of augmentation as the images can be encountered under these conditions in the real world, additionally other forms of augmentation such as noise to mimic bad camera quality has been identified as a possible way to augment my data and to mimic other real-world conditions not represented in the dataset.

There are various ways in which fabrics differ which allows us to keep them apart, but the most proven method of identifying a fabric is “the burn test” it is not a guaranteed way for everyone to identify fabric, for this purpose the information presented by James V. (2021) does provide useful information on the ways fabrics differ, from their structure, their behavior under certain conditions and the way they are commonly knitted or woven.

### Creating and adjusting a suitable Model

My basis for techniques and methods that I am going to use, such as creating a basic model, making training, and testing sets, visualizing results will come from what I learned from my Introduction to Artificial Intelligence module that I have taken at City, University of London.

Aside from this, I will use the cited sources mentioned above to identify methods and parameters to adjust to optimize and increase the accuracy of my module, the report for the Fabric Structure Classification module by Yasith Sanura Perara (2020), and the report of C. Kampouris et al. (2016) for fabric classification using microgeometry and reflectance will be the most useful as it works with the same fabrics dataset that I am going to use.

In addition to that tutorialspoint.com and keras.io will be very useful sources for information for the application of deep learning models for image classification.

## References:

Byju's Gate. Difference Between Machine Learning and Deep Learning. Byju's (2022). Available at: <<https://byjus.com/gate/difference-between-machine-learning-and-deep-learning/>> (Accessed: 15.02.2022)

LeCun, Y., Bengio, Y. & Hinton, G. Deep learning. *Nature* 521, 436–444 (2015). Available at: <<https://doi.org/10.1038/nature14539>> (Accessed: 15.02.2022)

CodeBullet. What are Neural Networks | | How AIs think. Youtube (2018). Available at: <<https://www.youtube.com/watch?v=JeVDjExBf7Y>> (Accessed: 15.02.2022)

Yasith Sanura Perara. AI for Textiles – Convolutional Neural Networks Based Fabric Structure Classifier. Towardsdatascience (2020) Available at: <<https://towardsdatascience.com/ai-for-textiles-convolutional-neural-network-based-fabric-structure-classifier-c0db5433501d>> (Accessed: 16.02.2022)

C. Kampouris, S. Zafeiriou, A. Ghosh, S. Malassiotis. (2016) The Fabrics Dataset. [online] ibug.doc. Available at: <<https://ibug.doc.ic.ac.uk/resources/fabrics/>> (Accessed: 14.02.2022)

C. Kampouris, S. Zafeiriou, A. Ghosh, S. Malassiotis. (2016) Fine-grained material classification using micro-geometry and reflectance, 14th European Conference on Computer Vision, Amsterdam.

Arun Gandhi. (2021) Data Augmentation | How to use Deep Learning when you have Limited Data — Part 2. [online] Available at: <<https://nanonets.com/blog/data-augmentation-how-to-use-deep-learning-when-you-have-limited-data-part-2/>> (Accessed: 18.02.2022)

James V., 2021. How To Tell If Fabric Is... (How to Identify Fabrics Easily). [online] Sewingiscool. Available at: <<https://sewingiscool.com/how-to-identify-fabrics/>> (Accessed: 14.02.2022)